FACTORS AFFECTING CONSTRUCTION LABOR HEALTH, PRODUCTIVITY FOR CONSTRUCTION OF PRE-STRESSED CONCRETE BRIDGES

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Abstract

Purpose – Construction labor productivity in bridge is of great interest to practitioners and researchers because it affects project cost and time overrun. This paper evaluates and ranks the importance, frequency and severity of project delay factors that affect the construction labor productivity for construction of Pre-stressed concrete bridges.

Design/erection / methodology

A total of 50 respondents consisting of owners contractors, and consulting participated in this study. The respondents were asked to indicate how important each item of a list of many bridges project related factors was to construction labor productivity for construction of Pre-stressed concrete bridges. The data were then subjected to the calculation of important indices which enabled the factors to be ranked.

Findings

The eleven most important factors identified by them were: design factor , equipment factor , execution and construction factor , external factor , financial factor , heathy and safety factor , labor factor , supervision factor , material factor , organization factor and other project factor .

Originality/value

From this study could be used by the project managers to take this factor at an early stage, hence minimizing the time, cost and maximizing factors that affect the construction labour productivity for construction of Pre-stressed concrete bridges.

Keywords: Construction, Construction Labor, Productivity, Pre-Stressed, Concrete, Bridges

Introduction:

Productivity is one of the most important factors affecting the overall performance of any organization, large or small (**Kazaz and Ulubeyli, 2007**). Productivity in construction sites is important because it influences time and cost objectives (**Moselhi and Khan, 2010**). In fact, the percentage of projects exceeding Cost or time forecasts is high (**González et al., 2010; Johansen and Wilson, 2006**).In Egypt has experienced a construction bridges boom during the past years, attracting construction professionals in bridges. According to the bridges and roads Ministry, However, construction Pre-stressed beams in bridges faces some critical problems like poor labour productivity. Labor productivity is simply defined as the amount of goods and services that a laborer produces in a given amount of time (**Al-Saleh, 1995**). Labor productivity plays a key role in determining the success of a project. However, it might affected by many unexpected variables. These variables may include factors related to labour, Poor labor productivity is one of the main causes affecting cost and time overruns in construction Pre-stressed beams in bridges projects.

This paper aims at identifying factors affecting labor productivity for Construction of Pre-stressed Concrete Bridges in Egypt from the owners and consulting and contractors' perspective. The questionnaire survey and the identified factors design factor , equipment factor , execution and construction factor , external factor , financial factor , health and safety factor , labor factor , supervision factor , material factor , organization factor and other project factor were ranked according to their impact level. It is hoped that these findings will guide efforts to enhance the performance of the construction of Pre-stressed Concrete beams Bridge.

Literature Review:

Pre-stressed concrete in bridges projects differ from conventional structural engineering projects mainly in the special problems that have to be considered during construction, transportation, installation, and operation. Pre-stressed concrete is the most recent of the major forms of the construction to be introduced into structural engineering, although several patents were taken out in the last century for various pre-stressing schemes they were unsuccessful because low strength steel was used and low productivity. The idea of pre-stressing or preloading is not new but in differs from conventional structural engineering projects mainly in the special problems that have to be considered during construction, transportation, installation, and fabrication. Through better utilization of available resources. **Encyclopaedia (2010)** asserted that productivity is often used as a measure of, index of growth, measure of efficiency and wages and price analysis. An overall rise in a nation's labor productivity signifies the availability of a larger quantity of goods and services per worker than before and accordingly, a potential for a higher real income per worker. Countries with high labor productivity are usually those with high real wages, while those generally with low in productivity are those with low real wages (**Alinaitive, Mwakali and Hansson, 2007**)

Olomolaiye and Ogunlana (1989) noted that the production outputs in key building trades in Nigeria were lower than they ought to be. The inefficient method, lack of appropriate tools and poor supervision and training were advanced as reasons for the low productivity of Nigerian workers. **Thomas (1991**) stated that the factors undermining on the productivity of construction workers are as follows. Type, scope, layout and complexity; Time frame (percentage complete); Construction methods; Weather ;Skill of the work force; Work practice; Length of work day ;Availability of materials; Incentives ;Degree of supervision ; Enabling environment; Government regulations and organization size and maturity. A study carried out by **Alinaitive, Mwakali and Hansson (2007)** ranked incompetent supervision and lack of skills of the workers as the two most significant causes of low productivity of construction workers in developing countries. Similarly, **Odusami and Unoma (2011)** noted that the problems of low productivity can be directly linked to poor and inadequate training of construction skilled workers. Previous studies have identified various factors that affect labor productivity on construction sites. Therefore, this research aim was to find out the most significant

factors affecting the productivity of a construction worker on a site and productivity of a qualified skilled worker at selected level per day, to analyses the relationship between working height and the productivity of worker on a construction site. **Abolfazl Sherafat (2013),** "Designed a Model for Measuring Manpower Productivity in the Project based Service Organizations", In the designed model, added-value is calculated so that all of the organizations outputs include current activities and also the investments that will be exploited in the future. As a result, the calculated value is overall reflects of the organizations performance and also manpower productivity is calculated actually. Since, manpower productivity is the ratio of added-value to the organizations manpower, it is possible to measure every units and employee's productivity through determining every their role by organizational excellence models in creating the added-value and then determining their role in the units added-value. The designed model is implemented in an organization with the mission of supplying and distributing the electricity energy and then every units productivity in this organization is calculated through this method. **K.W. CHA.U and A. WALKER , (1998) ,** The measurement of total factor productivity of the Hong Kong construction industry. This paper presents a method of indirect to measuring the total factor productivity of the construction industry using various construction cost and price indices and other statistics. Although special reference has been made to the construction industry of Hong Kong, the same approach should also be applicable to other countries. **Xiaolong Xue, (2008),** Measuring the Productivity of the Construction Industry in China by Using DEA-Based. Data envelopment analysis _DEA_ measures the relative efficiency of decision-making units and avoids any functional. Specification to express production relationship between inputs and outputs. DEA-based Malmquist productivity index _MPI_ measures the Productivity change over time. In this paper, the MPI is used to measure the productivity changes of Chinese construction industry from1997 to 2003. The results of analyses indicate that productivity of the Chinese construction industry experienced a continuous improvement from 1997 to 2003 except for a decline from 2001 to 2002... It is found that there are gaps in productivity development level among western, midland, eastern, and northeastern regions in the Chinese construction industry. **Ashok Kumar Katta (2018),** Identifying and evaluating the factors which influence productivity are critical issues faced by construction managers. **K.W. CHAU and A. WALKER (2000),** an operational framework for productivity analysis has been developed with special consideration of the problem of availability of data. The framework has been shown to have potential for estimating the trend of total factor productivity of the building industry of Hong Kong

and other countries. As productivity measurements is the first step in productivity analysis the present framework provides as basis for detailed investigation of the major determinants of productivity changes**. Martin Loosemore, (2014), Improving construction Productivity: a subcontractor's perspective.** Study the relationship between subcontractors and contractors well and participation among them in the project phases to improve the productivity of construction, taking into consideration the subcontractors from project start to an end and providing data and full information for the project to subcontractors in a timely. **George (2009),** identify factors for improving productivity on future construction projects. It was recommended for improving construction productivity are categorized and tabulated into 10 major areas. **Silva and Ruwanpura (2006)** on a study to improve productivity of slab concreting operations on four commercial construction sites in Alberta, indicated that productivity losses during concreting operations were mainly caused due to variability in the pouring rates and site layout factors restricting the movement of concrete trucks on site during concreting. **Rami Hughes and David (2014**), **a review of enabling factors in construction industry productivity in an Australian environment.** Reviewed the factors that effect on construction industry productivity by a structured questionnaire and he ranked factors to primary and secondary factors as perceived by the project managers who were surveyed. **Tarek zayed (2014),** in this study a case productivity model for automatic climbing system he is observed that duration of activities is similar across floors except concrete pumping Time because it is a function of height. **Sherif Mohamed (2014),** studied the thermal environmental effects on construction worker's productivity. **Polycarp Olaku Alumbugu (2014),** studied analysis the relationship between working height and productivity of masonry worker on construction site by investigating two project sites. **Shah et al. (2014),** studied analysis of factors influencing productivity in Central Gujarat Region of India, so it was identified and ranked the key factors affecting the project level productivity. **Ibrahim Mahamid (2013), Principal Factors Impacting Labor Productivity of Public Construction Projects in Palestine,** This study aims at identifying the factors negatively affecting labor productivity of public construction projects in the West Bank in Palestine from contractors' viewpoint, The results show that the poor labor productivity of public construction is mostly affected by the materials and equipment. **Abdulaziz M. (2013),**

studied the factors that impact the motivational level of master craftsmen involved in primary construction trades a structured questionnaire survey comprising 23 factors, which were shortlisted based on relevant previous research on motivation, the input of local industry experts, and numerous interviews with skilled operatives, was distributed to a large number of master craftsmen Using a relative importance index technique. **Osama Moselhi (2009),** studied an analysis of labour productivity of formwork operations in building construction. **Kazaz (2008),** studied the factors influencing construction labour productivity in Turkey. **Paul M.Goodrum (2004),** this paper examines how changes in equipment technology have influenced labor productivity in the U.S. construction industry over a 22-year time period in three parts. **Makulsawatudom (2001),** presented factors affecting construction productivity, and their potential for improvement for labor productivity, to make a questionnaire survey. **Robert c.Ford (2000),** this study conducted that the weather has an influence on the productivity of people at work system. **Seonghoon Kim (2015): Earthmoving Productivity in Urban Bridge Construction.** This research also identified significant factors for the truck bunching and showed that the match factor from the urban earthmoving project does not linearly correlate with the productivity of each truck. Reducing the hauling distance for urban earthmoving projects was the principal method for improving productivity. **R. Edward Minchin (2015),** Improving Productivity on A Troubled Bridge Project**:** This paper reports on a case study that involved a bridge constructed under adverse conditions. The major challenges facing the contractor were clearly identified through analysis. The bridge was constructed by an established, experienced bridge contractor that faced many daunting challenges in the constructing of the Foundation of the bridge ranging from over-design to the Project Manager managing his first construction project. However, the biggest challenge was unforeseen site conditions in the form of some of the most difficult clay imaginable through which to drive piles. These challenges forced the contractor into several tactical maneuvers. In sharing both the methods adapted by the contractor and the results of the adaptations, this paper quantifies for researchers and practitioners how a good contractor made sound, fundamental decisions to overcome severe challenges and improve productivity rates mid-project to eventually make the project a success. A seeming disaster early on, the project was eventually completed in less than the contract

duration and at a sizeable profit for the contractor. **Ashwin Maru (2015),** Construction of Bridge Decks with Pre-Cast, Pre-Stressed concrete the objective of this paper that the productivity and the efficiency of construction prestressed are measured not only by the requirements satisfied for the project, but also by the durability of the project. The aim of the research is to analyze by means of case study, the construction efficiency and durability of Decks with pre-cast, pre-stressed concrete deck planks to identify by means of the case study the issues that had existed for the original deck planks so as to compare how prestressed and precast concrete deck planks out rate.

_ To identify the early performance specifics of the precaset prestressed concrete deck planks

_ To recommend based on case study analysis, the and mean that precast,prestressed deck planks can add to the durability of the deck planks

Ashwin Maru (2009), Construction of Bridge Decks with Pre-Cast, Pre-Stressed Concrete Deck Planks. The case study is that of the bridge deck replacements that were carried out by the Illinois Department of transportation in 1999-2000. The bridge deck replacements were done by means of PPCs. The research also aims to find whether the bridge deck replacements that were carried out had early performance issues. It was established that there were indeed early performance issues, but these could be mitigated by means of load testing and the use of high-grade materials. **Seonghoon Kim (2007),** After the September 11, 2001, terrorist attacks, Hurricane Katrina, and the tsunami in South Asia, rapid replacement of damaged infrastructure such as bridges after extreme events has received close attention from government agencies, engineering and construction communities, and the general public. To enhance the capability of rapid replacement of damaged infrastructure after extreme events, there is an urgent need to develop innovative technologies that could be used to produce an accurate and reliable construction schedule to support rapid bridge replacement operations. To respond to this emergency need, a wireless real-time productivity measurement system was developed and tested in a construction project site. The preliminary test results indicated that the developed system can measure the onsite construction productivity accurately. Additional field experiments are scheduled in the near future to fully test the system. Results will be

reported at a later time. If successful, the capability of rapid bridge replacement will be improved significantly. **H.Randolph (2003), Role of Workforce Management in Bridge super structure.** This paper describes the results of four case studies of high way bridges construction performed by established contractors with little bridge building experience, in which workforce management had a significant negative effect on a labor productivity. The contractor's lack of experience in bridge construction seemed to be the cause of several problems that plagued each of the four project. The baseline of productivity of each was calculated and the loss of labor efficiency was estimated to be 80, 75, 32 and 70% the schedule slippage on the four case study was estimated to be between 127 and 329 %.

S.B. Wijekoon (2002) Evaluation of Labour Productivity In Bridge Construction Projects: The main objective of this study is to identify the factors influencing labour productivity in bridge construction projects; to compare actual labour productivity rates with estimated rates and to make recommendations for improving labour productivity in identified items in bridge construction project. **Seonghoonkin & yong Bai (2013),** the main objectives of this paper is how to developing a model to enhance labor productivity using bridges construction by using many steps to developing in the bridges.

Research Method

11 mains factors that might affect labor productivity in the construction Pre-stressed bridges projects. The factors were tabulated into a questionnaire form, and then the draft questionnaire was discussed with three local experts in construction bridges owners, contractor and the consulting to evaluate the content of the questionnaire. Modifications and changes have been done. The questionnaire is divided into two main parts. Part I is related to the main factor that effect the productivity in Pre-stressed beams that includes the list of the identified factors , and Part II is related the sub main includes the list that explain the main factor factors .

50 contractors working on construction bridges projects were successfully questioned. The questionnaire gave each respondent an opportunity to identify factors that they perceived as likely to contribute to poor labor productivity by responding on a scale from 5 (very high) to 1 (not high). For each factor, the mean value of the

respondents' importance rating was named the importance index. From calculating the important index we will calculate Frequency Index and Severity index.

The factors were taken from relevant literature, as well as from the authors' practical experience. The "importance index" was derived for each factor using the following formula (Lim and Alum, 1995):

$$\textbf{Important Index} = \frac{5n_5+4n_4+3n_3+2n_2+1n_1}{5(n_5+n_4+n_3+n_2+n_1)}$$

Where n1 is the number of respondents who answered "strongly important", n2 the Number of respondents who answered "important", n3 the number of respondents who answered "neutral", n4 the number of respondents who answered "not important", and n5 the number of respondents who answered "strongly not important".

The respondents were then asked to rate the frequency of occurrence for each factor According to three ordinal scales: high (3), medium (2), or low (1). The "frequency Index" for each factor was derived from the following formula:

$$\textbf{Frequency Index} = \frac{3n_1+2n_2+1n_1}{3(n_3+n_2+n_1)}$$

Where n1 is the number of respondents who answered "high", n2 the number of respondents who answered "medium", and n3 the number of respondents who answered "low". Finally, an overall index, the multiplication of "importance index" by the "frequency index" was named the "severity index". The severity index was used to rank the Overall implication of each factor on labour productivity for residential projects.

"Severity index" = "Importance index" * "Frequency index"

The questionnaire in this research is based on the first to range the main factors after that we ranged the sub main includes the list that explain the main factors.

Results of the arrangement the main factors of project delay on labor productivity:

1. Material Factors
2. Execution and construction Factors
3. Equipment Factors
4. Leadership and supervision Factors

5. Design Factors
6. External Factors
7. Labors Factors
8. Financial Factors
9. Health and Safety Factors
10. Organization Factors
11. Project Factors

Type	Factors	Factors Effecting on Labor Productivity					Range Of Groups
		n1	n2	n3	n4	n5	
		1	2	3	4	5	
The design	Slow response to questions with drawing	11	10	11	7	2	5
	the Structure system and the design of cables	8	13	10	7	3	
	Technical specifications are unclear	5	11	12	8	5	
	The difficulty of the design level	5	14	13	5	4	
	Poor design ability to build	7	8	14	5	7	
	the rework in Drawings	8	14	7	8	4	
	Errors in Drawings	9	12	12	4	4	
	slow response in the Shop Drawings and schedule time	7	11	9	6	8	
	Slow response to approved the drawing from the Competent authorities	7	6	20	5	3	
	Lack of graphics and workshop	15	7	9	5	5	
	Lack of clarity of drawings and dimensions compared to nature	12	15	12	1	1	
The Equipment	Lack of equipment and lack of availability	8	17	8	5	3	3
	Lack of a crane for the prestressed beams	10	9	14	5	3	
	Available of cables and tools	12	12	7	6	4	
	Hardware crashes	12	16	7	3	3	
	Lack of maintenance of equipment permanently	7	13	9	7	5	
Construction Execution and	Change in schedule	6	11	16	4	4	2
	Delaying expropriation of the land on which the bridge is built	10	11	14	4	2	
	Delay in removing obstructions (electricity, cables and wires)	12	12	9	6	2	
	Construction technology (construction method, materials, equipment system)	11	9	13	4	4	
	Work interruption (design changes, ... etc)	9	12	7	6	7	
External	Lack of communication between workers and engineers in a friendly manner	9	12	10	4	6	6
	Lack of protection from weather conditions	11	7	13	4	6	
	Climate conditions (temperature, humidity and floods)	8	10	13	5	5	
	Political issues and surrounding events such as expropriation	11	7	9	8	6	
Financial	Delay payment of dues	14	10	8	5	4	8
	Stimulate workers	6	11	12	6	6	
	Operating system work (daily pay, lump sum, etc.)	2	11	12	8	8	

Health and Safety	Lack of site safety resources	17	9	10	5	0	9
	The conflicting safety policies established by different supervisors	18	8	10	5	0	
	Lack of engineers and observers for safety and security	18	9	7	7	0	
	Services provided to workers (social insurance, medical care)	6	5	11	5	14	
	Work at heights	18	12	6	3	2	
Labors	Weakness of experience, skill and performance of labor (working class)	14	15	6	6	0	7
	Wrong behaviors by labor	6	8	17	7	3	
	Lack of skilled and specialized labor	24	12	4	1	0	
	There is no communication between the agent and the supervisor	9	10	10	5	7	
	The worker is not familiar with the daily specialized program	9	8	8	14	2	
	Employment misunderstanding of required changes	17	16	4	3	3	
	Share items in personal discussions	6	9	10	12	4	
	Delay in receipt from the supervisor of the worker	8	7	13	9	4	
	Laziness after waiting	8	8	11	14	0	
	Lack of rest time during the working day	7	10	11	10	3	
	Absence of the authority to discipline labor	8	13	11	4	5	
Leadership and Supervision	clarity of instructions and information exchange	10	9	13	6	3	4
	Management of subcontractors	7	15	5	8	6	
	Overbooking	16	11	8	6	0	
	Lack of proper administrative and administrative support	5	12	13	11	0	
	Different business rules by supervisors	14	11	9	5	2	
	Efficiency of supervision work	10	13	9	8	1	
	Decisions are slow	12	15	8	4	2	
	Notify him of errors when they occur	13	14	9	5		
	Unqualified managers	15	10	6	4	6	
	Additional work (after more than 4 hours of 8 hours / day)	12	11	6	6	6	
	The consultant and site staff are advised to work extra days on Fridays and public holidays	13	7	10	6	5	
Material	Lack of materials and lack of inventory at the project site by purchasing department procurement department	23	16	2	0	0	1
	High prices of materials continuously	28	6	4	3	0	
	Availability of building materials and ease of circulation (existence of concrete mixer and asphalt)	18	17	0	6	0	
	The slow adoption of materials and lack of sufficient technical publication	17	15	7	2	0	
	The problem of coordination with suppliers	7	20	9	5	0	
Organization	Do not sequence work tasks	8	10	12	6	5	10
	Lack of allocation of appropriate resources	4	12	13	12	0	
	Lack of coordination between consultants (public and private)	26	9	3	1	2	
Project Factors	Project size	14	17	8	1	1	11
	Initial equipment of the project	15	11	8	5	2	

	Preparing the site for the bridge and its preliminary works	**14**	**8**	**12**	**7**	**0**	
	Type of management (individual or corporate)	**3**	**13**	**12**	**7**	**6**	
	Sign up for a large number of simultaneous work in many tasks	**6**	**12**	**12**	**6**	**5**	
	Traffic equipment	**18**	**13**	**10**	**0**	**0**	
	Poor supervision of operations	**20**	**14**	**7**	**0**	**0**	
	Slow response consultant	**9**	**12**	**8**	**8**	**4**	
	Slow adoption of both graphics and materials	**21**	**13**	**7**	**0**	**0**	
	Slow delivery and abstract work	**23**	**12**	**6**	**0**	**0**	

Results of the arrangement the sub main factors of project delay on labor productivity:

1. **Material Factors:**

Factors	Importance Index	Frequency Index	Severity index
Lack of materials and lack of inventory at the project site by purchasing department procurement department	0.902439024	0.837398374	0.755700972
High prices of materials continuously	0.887804878	0.877192982	0.778776209
Availability of building materials and ease of circulation (existence of concrete mixer and asphalt)	0.829268293	0.838095238	0.695005807
The slow adoption of materials and lack of sufficient technical publication	0.829268293	0.752136752	0.62372316
The problem of coordination with suppliers	0.741463415	0.648148148	0.480578139

1-Lack of materials and lack of inventory at the project site by purchasing department procurement department (Important index = 0.9024)

2-High prices of materials continuously (Important index = 0.8878)

3-Availability of building materials and ease of circulation (existence of concrete mixer and asphalt) (Important index = 0.8292)

4-The slow adoption of materials and lack of sufficient technical publication (Important index = 0.8292)

5-The problem of coordination with suppliers (Important index = 0.74146)

2. **Execution and construction Factors:**

Factors	Importance Index	Frequency Index	Severity index
Change in schedule	0.653658537	0.565656566	0.369746243

Delaying expropriation of the land on which the bridge is built	0.712195122	0.628571429	0.447665505
Delay in removing obstructions (electricity, cables and wires)	0.726829268	0.696969697	0.506577975
Construction technology (construction method, materials, equipment system)	0.692682927	0.646464646	0.447795023
Work interruption (design changes, ... etc)	0.648780488	0.69047619	0.44796748

1-Delay in removing obstructions (electricity, cables and wires) (Important index = 0.726)

2-Delaying expropriation of the land on which the bridge is built (Important index = 0.712)

3-Construction technology (construction method, materials, equipment system) (Important index = 0.692)

4-Change in schedule (Important index =0.625)

5-Work interruption (design change…... etc.) (Important index = 0.648)

3. **Equipment Factors:**

Factors	Importance Index	Frequency Index	Severity index
Lack of equipment and lack of availability	0.707317073	0.666666667	0.471544715
Lack of a crane for the Pre-stressed beams	0.687804878	0.626262626	0.430746489
Available of cables and tools	0.707317073	0.720430108	0.509572515
Hardware crashes	0.751219512	0.714285714	0.536585366
Lack of maintenance of equipment permanently	0.648780488	0.643678161	0.417605831

1-Hardware crashes (Important index = 0.752)

2-Lack of equipment and lack of availability (Important index = 0.707)

3-Available of cables and tools (Important index = 0.707)

4-Lack of a crane for the Pre-stressed beams (Important index = 0.687)

5-Lack of maintenance of equipment permanently (Important index = 0.648)

4. **Design Factors:**

Factors	Importance Index	Frequency Index	Severity index
Slow response to questions with drawing	0.702439	0.666667	0.468293
the Structure system and the design of cables	0.678049	0.645161	0.437451
Technical specifications are unclear	0.614634	0.583333	0.358537
The difficulty of the design level	0.653659	0.583333	0.381301
Poor design ability to build	0.614634	0.586207	0.360303
the rework in Drawings	0.668293	0.678161	0.45321
Errors in Drawings	0.687805	0.636364	0.437694
slow response in the Shop Drawings and schedule time	0.614634	0.641975	0.39458
Slow response to approved the drawing from the Competent authorities	0.643902	0.535354	0.344715
Lack of graphics and workshop	0.707317	0.731183	0.517178
Lack of clarity of drawings and dimensions compared to nature	0.77561	0.666667	0.517073

1-Lack of clarity of drawings and dimensions compared to nature (Important index = 0.775)

2-Lack of graphics and workshop (Important index = 0.707)

3-Slow response to questions with drawing (Important index = 0.702)

4-Errors in Drawings (Important index = 0.687)

5-the Structure system and the design of cables (Important index = 0.678)

6- The rework in Drawings (Important index = 0.668)

7- The difficulty of the design level (Important index = 0.653)

8- Slow response to approved the drawing from the competent authorities (Important index = 0.643)

9- Technical specifications are unclear (Important index = 0.614)

10-Technical specifications are unclear (Important index = 0.614)

5. **External Factors:**

Factors	Importance Index	Frequency Index	Severity index
Lack of communication between workers and engineers in a friendly manner	0.668292683	0.655913978	0.438342512
Lack of protection from weather conditions	0.663414634	0.64516129	0.428009441
Climate conditions (temperature, humidity and floods)	0.653658537	0.612903226	0.400629426
Political issues and surrounding events such as expropriation	0.643902439	0.691358025	0.445167118

1- Lack of communication between workers and engineers in a friendly manner (Important index = 0.668)

2- Lack of protection from weather conditions (Important index = 0.663)

3- Climate conditions (temperature, humidity and floods) (Important index = 0.653)

4-Political issues and surrounding events such as expropriation (Important index = 0.643)

6. **Labors Factors:**

Factors	Importance Index	Frequency Index	Severity index
Weakness of experience, skill and performance of labor (working class)	0.780487805	0.742857143	0.579790941
Wrong behaviors by labor	0.634146341	0.548387097	0.347757671
Lack of skilled and specialized labor	0.887804878	0.833333333	0.739837398
There is no communication between the agent and the supervisor	0.643902439	0.655172414	0.421867115
The worker is not familiar with the daily specialized program	0.63902439	0.68	0.434536585
Employment misunderstanding of required changes	0.790697674	0.783783784	0.619736015
Share items in personal discussions	0.604878049	0.613333333	0.37099187
Delay in receipt from the supervisor of the worker	0.629268293	0.607142857	0.382055749
Laziness after waiting	0.648780488	0.62962963	0.408491418
Lack of rest time during the working day	0.63902439	0.619047619	0.395586527
Absence of the authority to discipline labor	0.673170732	0.635416667	0.427743902

1-Lack of skilled and specialized labor (Important index = 0.887)

2- Employment misunderstanding of required changes (Important index = 0.722)

3-Weakness of experience, skill and performance of labor (working class) (Important index = 0.780)

4- Absence of the authority to discipline labor (Important index = 0.722)

5- There is no communication between the agent and the supervisor (Important index = 0.643)

6- Laziness after waiting (Important index = 0.648)

7- The worker is not familiar with the daily specialized program (Important index = 0.639)

8- Lack of rest time during the working day (Important index = 0.639)

9- Wrong behaviors by labor (Important index = 0.634)

10- Delay in receipt from the supervisor of the worker (Important index = 0.629)

11- Share items in personal discussions (Important index = 0.604)

7. Financial Factors:

Factors	Importance Index	Frequency Index	Severity index
Delay payment of dues	0.72195122	0.729166667	0.526422764
Operating system work (daily pay, lump sum, etc.)	0.556097561	0.533333333	0.296585366
Stimulate workers	0.624390244	0.597701149	0.373198766

1-Delay payment of dues (Important index = 0.722)

2- Operating system work (daily pay, lump sum, etc.) (Important index = 0.556)

3-Stimulate workers (Important index = 0.624)

8. Health and Safety Factors:

Factors	Importance Index	Frequency Index	Severity index
Lack of site safety resources	0.785365854	0.731481481	0.574480578
The conflicting safety policies established by different supervisors	0.790243902	0.740740741	0.585365854
Lack of engineers and observers for safety and security	0.785365854	0.774509804	0.608273553

Services provided to workers (social insurance, medical care)	0.52195122	0.590909091	0.308425721
Work at heights	0.8	0.777777778	0.622222222

1-Work at heights (Important index = 0.8)

2-The conflicting safety policies established by different supervisors (Important index = 0.790)

3-Lack of site safety resources (Important index = 0.785)

4-Lack of engineers and observers for safety and security (Important index = 0.785)

5-Services provided to workers (social insurance, medical care) (Important index = 0.521)

9. Organization Factors:

Factors	Importance Index	Frequency Index	Severity index
Project size	0.804878049	0.717948718	0.577861163
Initial equipment of the project	0.756097561	0.735294118	0.555954089
Preparing the site for the bridge and its preliminary works	0.741463415	0.68627451	0.508847441

1- Lack of coordination between consultants (public and private) (Important index = 0.873)

2- Do not sequence work tasks (Important index = 0.648)

3-Lack of allocation of appropriate resources (Important index = 0.639)

10. Project Factors:

Factors	Importance Index	Frequency Index	Severity index
Project size	0.804878049	0.717948718	0.577861163
Initial equipment of the project	0.756097561	0.735294118	0.555954089
Preparing the site for the bridge and its preliminary works	0.741463415	0.68627451	0.508847441
Type of management (individual or corporate)	0.6	0.55952381	0.335714286
Sign up for a large number of simultaneous work in many tasks	0.63902439	0.6	0.383414634

Traffic equipment	0.83902439	0.731707317	0.613920286
Poor supervision of operations	0.863414634	0.772357724	0.666864961
Slow response consultant	0.668292683	0.67816092	0.45320998
Slow adoption of both graphics and materials	0.868292683	0.780487805	0.67769185

1-Slow delivery and abstract work (Important index = 0.882)

2-Slow adoption of both graphics and materials (Important index = 0.868)

3-Poor supervision of operations (Important index = 0.863)

4- Traffic equipment (Important index = 0.839)

5- Project size (Important index = 0.804)

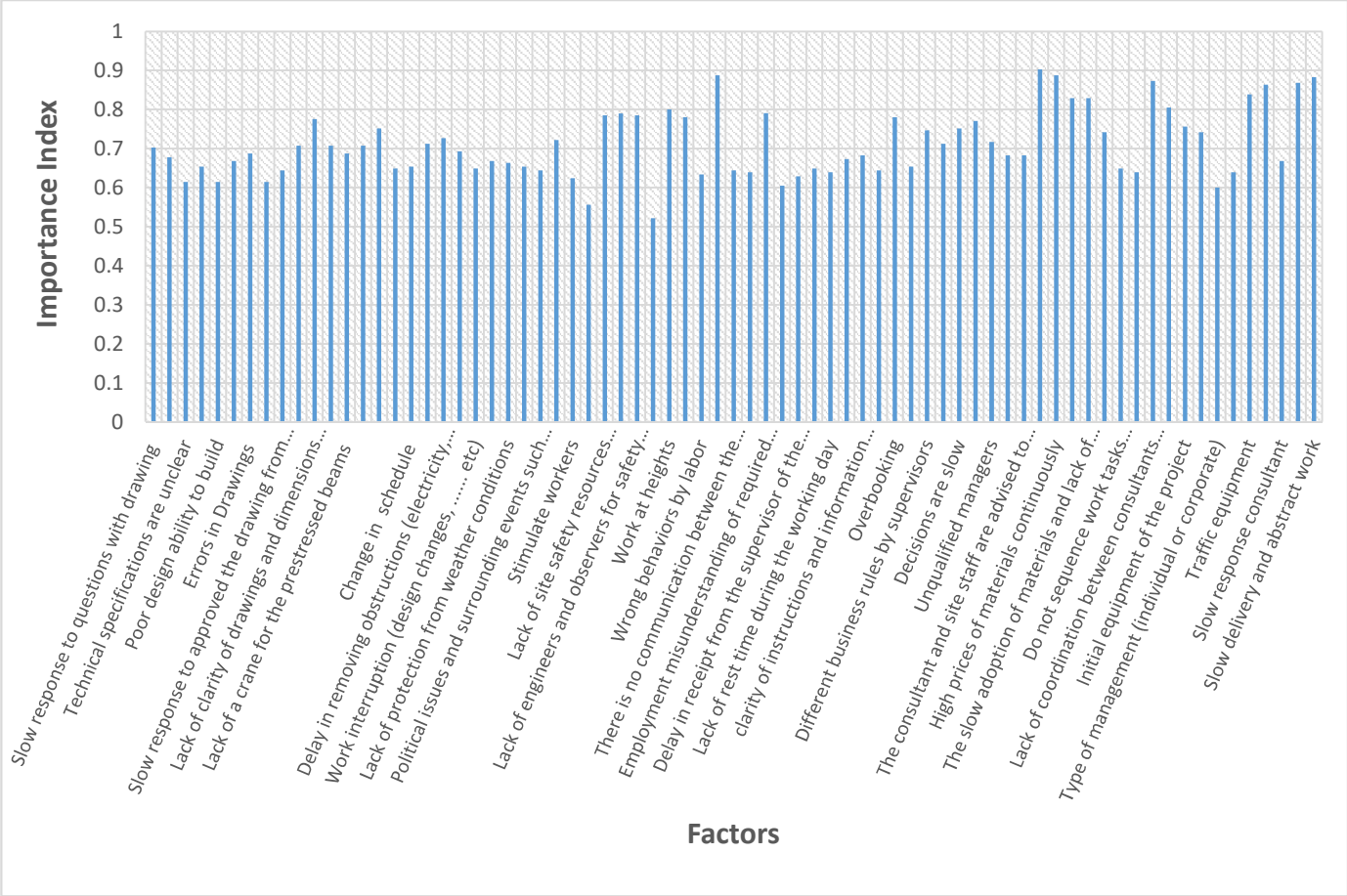
6-Initial equipment of the project (Important index = 0.756)

7-Preparing the site for the bridge and its preliminary works (Important index = 0.7414)

8-Slow response consultant (Important index = 0.668)

9-Sign up for a large number of simultaneous work in many tasks (Important index = 0.639)

10-Type of management (individual or corporate) (Important index = 0.6)



Recommendation

The results of the survey indicated the top important, frequent and severe factors in bridges that are adversely affecting construction labor productivity in prestressed beams bridges.

This would affect the workers' motivation and productivity in bridges. Mentioned below are the recommendations which were found to be important factors for improving the crew productivity for the Construction of prestressed beams in bridge project: This study is one of the few that has been done in the area of crew productivity for the Construction of beams in bridges projects. It is hoped that future studies will improve on the techniques used in this study, while taking into consideration the difficulties encountered in this study.

Finally, this research provides a basis for future work in for improving the crew productivity for the construction in bridges beams, given the numerous factors affecting crew productivity. It is hoped that future studies will improve on the techniques used in this study, while taking into consideration the difficulties encountered in this study.

Conclusion

The Egyptian construction bridges experiences time and cost overrun due to various project delay factors that affect construction labor productivity in the main and sub main factors. This paper has identified and ranked those factors that affect construction labor productivity. Results indicated that the eleven most important factors that affect labor in prestressed beams, they are as follows ranged by important:

1. Material Factors
2. Execution and construction Factors
3. Equipment Factors
4. Leadership and supervision Factors
5. Design Factors
6. External Factors
7. Labors Factors
8. Financial Factors
9. Health and Safety Factors
10. Organization Factors
11. Project Factors

Finally, the most severe project delay factors are listed below ranged by the important index from all factors:

Factors	Importance Index	Rank
Lack of materials and lack of inventory at the project site by purchasing department procurement department	0.902439024	1
Lack of skilled and specialized labor	0.887804878	2
High prices of materials continuously	0.887804878	3
Slow delivery and abstract work	0.882926829	4
Lack of coordination between consultants (public and private)	0.873170732	5
Slow adoption of both graphics and materials	0.868292683	6
Poor supervision of operations	0.863414634	7

Traffic equipment	0.83902439	8
Availability of building materials and ease of circulation (existence of concrete mixer and asphalt)	0.829268293	9
The slow adoption of materials and lack of sufficient technical publication	0.829268293	10
Project size	0.804878049	11
Work at heights	0.8	12
Employment misunderstanding of required changes	0.790697674	13
The conflicting safety policies established by different supervisors	0.790243902	14
Lack of site safety resources	0.785365854	15
Lack of engineers and observers for safety and security	0.785365854	16
Weakness of experience, skill and performance of labor (working class)	0.780487805	17
Overbooking	0.780487805	18
Lack of clarity of drawings and dimensions compared to nature	0.775609756	19
Notify him of errors when they occur	0.770731707	20
Initial equipment of the project	0.756097561	21
Hardware crashes	0.751219512	22
Decisions are slow	0.751219512	23
Different business rules by supervisors	0.746341463	24
The problem of coordination with suppliers	0.741463415	25
Preparing the site for the bridge and its preliminary works	0.741463415	26
Delay in removing obstructions (electricity, cables and wires)	0.726829268	27
Delay payment of dues	0.72195122	28
Unqualified managers	0.717073171	29
Delaying expropriation of the land on which the bridge is built	0.712195122	30
Efficiency of supervision work	0.712195122	31
Lack of graphics and workshop	0.707317073	32
Lack of equipment and lack of availability	0.707317073	33
Available of cables and tools	0.707317073	34
Slow response to questions with drawing	0.702439024	35
Construction technology (construction method, materials, equipment system)	0.692682927	36
Errors in Drawings	0.687804878	37
Lack of a crane for the prestressed beams	0.687804878	38
clarity of instructions and information exchange	0.682926829	39
Additional work (after more than 4 hours of 8 hours / day)	0.682926829	40
The consultant and site staff are advised to work extra days on Fridays and public holidays	0.682926829	41

the Structure system and the design of cables	0.67804878	42
Absence of the authority to discipline labor	0.673170732	43
the rework in Drawings	0.668292683	44
Lack of communication between workers and engineers in a friendly manner	0.668292683	45
Slow response consultant	0.668292683	46
Lack of protection from weather conditions	0.663414634	47
The difficulty of the design level	0.653658537	48
Change in schedule	0.653658537	49
Climate conditions (temperature, humidity and floods)	0.653658537	50
Lack of proper administrative and administrative support	0.653658537	51
Lack of maintenance of equipment permanently	0.648780488	52
Work interruption (design changes, ... etc.)	0.648780488	53
Laziness after waiting	0.648780488	54
Do not sequence work tasks	0.648780488	55
Slow response to approved the drawing from the Competent authorities	0.643902439	56
Political issues and surrounding events such as expropriation	0.643902439	57
There is no communication between the agent and the supervisor	0.643902439	58
Management of subcontractors	0.643902439	59
The worker is not familiar with the daily specialized program	0.63902439	60
Lack of rest time during the working day	0.63902439	61
Lack of allocation of appropriate resources	0.63902439	62
Sign up for a large number of simultaneous work in many tasks	0.63902439	63
Wrong behaviors by labor	0.634146341	64
Delay in receipt from the supervisor of the worker	0.629268293	65
Stimulate workers	0.624390244	66
Technical specifications are unclear	0.614634146	67
Poor design ability to build	0.614634146	68
slow response in the Shop Drwaings and schdule time	0.614634146	69
Share items in personal discussions	0.604878049	70
Type of management (individual or corporate)	0.6	71
Available amount of daily work (workload)	0.595121951	72
Work injuries and accidents	0.595121951	73
The initial delivery specified by the owner	0.590243902	74
The rate of the daily allowance varies	0.585365854	75
Incentive Programs	0.580487805	76
Project specifications (public and private)	0.575609756	77
Personal problems that lead to delay	0.575609756	78

Late work permits	0.556097561	79
Operating system work (daily pay, lump sum, etc.)	0.556097561	80
Lack of awareness programs for security and safety (guidance)	0.551219512	81
Physical exhaustion	0.541463415	82
Staff size and configuration	0.541463415	83
Distance between location and cities	0.531707317	84
Political competitions / performance within the company	0.526829268	85
Services provided to workers (social insurance, medical care)	0.52195122	86

It was concluded that the most important in prestressed beams, frequent and severe factors were related to the availability of all this factors in site. This result was substantiated by studies carried out in Egypt out 12 bridges in construction. By acknowledging the project delay factors that cause low construction labor productivity, project managers can address the problems at an early stage, thus minimizing time and cost overruns.

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